Envelope: Residential Construction Quality

Description

The Residential Standards have historically demonstrated compliance primarily via hourly computer simulation. Measures installed in the house are assumed to perform at a high level, regardless of installation quality. Recent field investigations, and the increasing propensity of construction litigation lawsuits, indicate that there are frequent instances of sub par installation related to energy efficiency, primarily surrounding ducts, HVAC equipment, insulation, air barriers, and building cavities well connected to the outdoors. Many of these energy defects can be attributed to “industry standard” installation practices, which emphasize speed and simplicity over attention to detail. An added factor is that many new homes include more complicated architecture, further challenging the abilities of the field installers to identify and install a continuous and contiguous thermal and pressure envelope.

To begin to address this situation, the concept of derating measure performance to reflect industry standard installation quality has been introduced into the standards. With the 1998 Standards, residential duct leakage assumptions were modified to reflect typical installation quality, while at the same time providing a credit for certified tight ducts. Other envelope measures, which could be treated in an analogous manner, include:

- Insulation installation quality (numerous installation problems degrade envelope performance).
- Wall framing (typical measured framing factors underestimate the amount of wood in the wall cavity).
- Fireplaces and other interior cavities connected to the attic (increases uncontrolled building leakage).
- Inadequate attention to maintaining an effective air barrier (sealing, draft stopping, etc.).
- Number of recessed lights penetrating the ceiling drywall.

Crediting third-party, HERS rater-certified improved performance could also be extended to the areas listed above. Adoption of a residential construction quality initiative would also help to nurture the “house as a system” construction philosophy, which has many benefits beyond improved energy efficiency. This initiative would apply to all building types covered by the residential standards.

Benefits

Improving the installation quality of these key features improves the integrity of the building envelope. Typical construction practice results in a wide range of defects contributing to increased energy use and oversized cooling systems. Correcting these defects would lead to improved building comfort, increased customer satisfaction, reduced use of framing materials, reduced cooling system sizing (once HVAC contractors gain confidence that building envelopes perform effectively), and reduced potential for construction defect litigation. The incorporation of Time Dependent Valuation (TDV) is not expected to significantly affect the benefits derived from this initiative.

Environmental Impact

The overall environmental impact of pursuing a quality assurance construction initiative is highly favorable, with benefits accruing from both reduced resource consumption in the construction process and reduced energy use. A potential detrimental impact relates to indoor air quality, which may be adversely affected under some limited situations (e.g., very tight buildings with simple architecture and no fireplace).

Type of Change

This initiative offers different implementation options. Adjusting framing factors for typical wall construction is a simple process involving recalculation of wall U-values. Other areas, such as visual insulation inspection, require a higher level of training and appropriate rating tools for the HERS rater. The approach most consistent with recent performance-based CEC initiatives involves derating “standard” performance (of wall insulation, for example), while simultaneously providing a credit for third-party documented “improved” performance. This ***modeling*** approach is more flexible than incorporating elements of construction quality as ***mandatory measures***, which would require the industry to undergo a rapid transformation in training, self-inspection, and quality control, and also require building officials to more closely regulate these details. The major downside of pursuing an optional credit is that it may not be accepted by the building industry if the *Standards* do not require it.

To accurately model some elements of the quality construction initiative could require minor modifications to the computer modeling tools. For example, additional wall types such as skylight shafts and kneewalls may need to be added. Implementation would require changes to the ACM and compliance documentation.

Measure Availability and Cost

There are no limitations related to specific measure availability in the area of enhanced residential construction quality. This initiative equires communicating improved installation procedures and helping the building community understand the value (i.e. compliance benefit, improved construction quality, and reduced litigation potential) of the approach. Currently, the construction industry is focused on streamlining the construction process, resulting in too little time and attention spent on the details that are critical in obtaining a finished product consistent with quality construction goals. There are likely additional costs associated with this initiative, although in the long term, cost savings arising from improved framing practice and equipment "right-sizing" may offset the additional installation labor and third-party inspections costs.

Without education of the building community, residential construction quality compliance credits may not be wholeheartedly embraced. Initial response to a compliance credit may not be strong, similar to the 1999 experience with the introduction of the tight duct credit. Insulation installers, among the lowest paid trades in the construction industry, must be better trained and compensated to competently complete their work.

One issue related to successful implementation of this initiative is whether the existing HERS infrastructure is sufficiently developed to perform the inspection task. Many HERS raters have been certified over the past few years and can be expected to competently perform a duct pressurization test following a step-by-step test method. However, a rigorous insulation and air barrier inspection requires additional understanding of where to look and what to look for. Additional education with a field-training component is likely needed to achieve the required level of competence.

The cost comparison should be relative to industry standard construction practice. Incremental costs are comprised of added labor in the installation process and third-party verification costs. The additional labor required to properly insulate, seal, and draft stop a house will vary with the complexity of the structure. On average, it is anticipated that this labor will cost about $300 per house. Third-party verification could add an additional $150 per house, less if a sampling method is used. Cost reductions could be realized from HVAC downsizing, and reduced liability insurance costs.

Useful Life, Persistence and Maintenance

This approach will provide persistent savings over the lifetime of the building and will eliminate a vast majority of the envelope defects commonly found in new homes. Equally as important, it will give the HVAC industry greater confidence in the thermal integrity of the building envelope, leading to future equipment downsizing.

Performance Verification

Performance verification is a key element of this initiative. Performance verification provides assurance to the builder and HVAC contractor that the installed building envelope (contiguous pressure and thermal barrier) meets the design intent. The HERS rater must be provided with the proper training and evaluation methodology to complete an accurate assessment of building envelope integrity. A detailed HERS-rater checklist or scorecard needs to be developed.

Cost Effectiveness

On a statewide-average basis, the residential construction quality initiative would clearly be cost-effective. Energy savings would be greatest in houses with complicated architecture (vaults, drop ceilings, cantilevered floors, turrets, interior columns/arches, multiple recessed lights and fireplaces, etc.) in the more severe climate zones, with smaller savings seen in simple, one-story, "box type" houses with eight foot ceilings.

Analysis Tools

MICROPAS/CALRES will be used to evaluate the energy savings impact of this initiative. The tool will likely need some modification to more accurately distinguish and itemize the defects, however the scope of the necessary modifications is not large. No need exists for complicated new algorithms to accurately model relevant parameters. New wall types (such as kneewalls and skylight shafts) may need to be characterized and inputs added for new infiltration parameters (e.g. number of fireplaces, number of recessed lights).

Relationship to Other Measures

The derating of existing building envelope parameters would increase the cost effectiveness of all other space conditioning efficiency measures, depending upon the climate zone and building design.

Bibliography and Other Research

Relevant research that will assist in developing this initiative include the following:

- The CEC's Phase I RCQA report (and ongoing results from Phase II field work).
- Data and reports from LBNL's Residential Commissioning project.
- Data collected from the Building Industry Institute's training and field evaluation efforts.
- Enermodal's framing factor study for ASHRAE.
- ComfortWise and CEC building envelope protocols for energy building. Find these at http://www.comfortwise.com/ and http://www.energy.ca.gov/efficiency/qualityhomes/index.html.
- Communications with leaders and innovators in the construction quality industry (Rick Chitwood, Stan Luhr of Pacific Property Consultants, Building Science Corporation, Florida Solar Energy Center, ORNL, ConSol, others).